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August 2, 2001

JC05 Rec'd PCT/PTO 02 AUG 2001

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		Date August 2, 2001 ATTORNEY'S DOCKET NUMBER GOT 143NP
INTERNATIONAL APPLICATION NO. PCT/JP99/07389 INTERNATIONAL FILING DATE 28 December 1999 (28.12.99) U.S. APPLICATION NO. To Be Assigned 09/890543 PRIORITY DATE CLAIMED		
TITLE OF INVENTION SIGNAL PROCESSOR FOR A JOYSTICK		
APPLICANT(S) FOR DO/EO/US Kazunori FUSHIMI		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1). 4. <input type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19 th month from the earliest claimed priority date. 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)). a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau (Form PCT/IB/308 enclosed). c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).		
6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)). 7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)). a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau). b. <input checked="" type="checkbox"/> have been transmitted by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input type="checkbox"/> have not been made and will not be made.		
8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). 10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).		
Items 11. To 16. below concern document(s) or information included:		
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 13. <input type="checkbox"/> A FIRST preliminary amendment. A SECOND or SUBSEQUENT preliminary amendment. 14. <input type="checkbox"/> A substitute specification. 15. <input type="checkbox"/> A change of power of attorney and/or address letter. 16. <input checked="" type="checkbox"/> Other items or information: -5 sheets of Drawings (Figs. 1 - 6)		

U.S. APPLICATION NO. To Be Assigned 99/890543	INTERNATIONAL APPLICATION NO. PCT/JP99/07389	ATTORNEY'S DOCKET NUMBER GOT 143NP	
17. The following fees are submitted:		CALCULATIONS PTG USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492(a)(1) - (5)):			
Search Report has been prepared by the EPO or JPO \$860.00			
International preliminary examination fee paid to USPTO (37 CFR 1.482) \$690.00			
No International preliminary examination fee paid to USPTO (37 CFR 1.482) But international search fee paid to USPTO (37 CFR 1.455(a)(2)) \$710.00			
Neither international preliminary examination fee (37 CFR 1.482) nor International search fee (37 CFR 1.455(a)(2)) paid to USPTO \$1000.00			
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2) - (4) \$100.00			
ENTER APPROPRIATE BASIC FEE AMOUNT =		\$ 860.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input checked="" type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e))		\$ 000.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	3 - 20 =	0	x \$18.00
Independent claims	3 - 3 =	0	x \$80.00
MULTIPLE DEPENDENT CLAIM(S) (IF APPLICABLE)		+ \$260.00	\$ 000.00
TOTAL OF ABOVE CALCULATIONS =		\$ 860.00	
Reduction of ½ for filing by small entity, if applicable.		\$	
SUBTOTAL =		\$ 000.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f))		+ \$ 000.00	
TOTAL NATIONAL FEE =		\$ 860.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +		\$ 40.00	
TOTAL FEES ENCLOSED =		\$ 900.00	
		Amount to be Refunded:	\$
		Charged:	

A check in the amount of \$900.00 to cover the above fee is enclosed.

The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 18-0002. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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NO.: 29,102

Date: August 2, 2001

SIGNAL PROCESSOR FOR A JOYSTICK INPUT DEVICE

Field of the Invention

This invention relates to a signal processor which outputs a signal according to the input amount of a joystick, and mainly controls the operation of a hydraulic actuator via a proportional solenoid valve in a work machine such as a forklift or a power shovel.

Background of the Invention

Tokukouhei 5-17401 which is published by the Japanese Patent Office in 1993 discloses a signal processor which outputs a current according to an input voltage from a joystick input device in order to control a device controlled by a proportional solenoid valve or the like. This is done by varying the valve opening of the proportional solenoid valve according to an amount by which a joystick inclines from a neutral position, and thereby controls the motion of a hydraulic actuator.

Fig. 6 is a characteristic diagram showing the relation of a time t from when the joystick is operated, and a displacement amount S of the hydraulic actuator which is hydraulically driven via the proportional solenoid valve. In a conventional device, as shown by the single dotted line, a time a until the actuator begins to move is long, and response is poor. This may be due to a delay with which the current output to the proportional solenoid valve appears due to the inductance produced in a coil, or to an overlap part in which the flow of working oil in the proportional solenoid valve cannot be changed over

even if the valve body moves slightly between each position.

Moreover, when the joystick is operated rapidly, the current output to the proportional solenoid valve appears suddenly after the time a from starting operation has elapsed, so the working oil flowrate controlled by the proportional solenoid valve changes suddenly, and the work device driven by the actuator suffers a shock.

It is therefore an object of this invention to provide a signal processor for a joystick input device which maintains good response when the joystick starts to be operated, and prevents a shock from occurring in an actuator or the like corresponding to sudden operation of the joystick.

Disclosure of the Invention

This invention provides a signal processor for a joystick input device which varies joystick voltage input value V_i according to an operating amount of a joystick from a neutral position, an input means which outputs the average value of the joystick voltage input value V_i read at every sampling time over a predetermined number of past occasions as a joystick voltage computation value V_{ic} , and computation means which computes an output computation value V_{oc} set according to the joystick voltage computation value V_{ic} . As the change of the output operation value V_{oc} is delayed relative to the change of the joystick voltage input value V_i , control sensitivity to sudden operation of the joystick can be mitigated. Further, the control response can easily be changed by changing the number of data which computes an average value in an input means.

Further this invention provides an operation start detecting means which detects an operation start when the joystick is pushed

over from the neutral position, wherein the computation means increases the output computation value V_{oc} to a predetermined value according to the joystick voltage computation value V_{ic} when operation starts. Hence, the output computation value V_{oc} is momentarily increased when the joystick starts operating, and control response is improved.

Further this invention provides an input means which outputs the average value of the joystick voltage input value V_i read at every sampling time over a predetermined number of past occasions as a joystick voltage computation value V_{ic} , and operation start detecting means which detects an operation start when the joystick is pushed over from the neutral position, wherein the computation means increases the output computation value V_{oc} to an effective maximum value when operation starts. As the output computation value V_{oc} increases momentarily when the joystick starts operating, the control response is improved. Thus, as the change of the output computed value V_{oc} relative to change of the joystick voltage input value V_i is delayed, control response to a sudden operation of the joystick can be suppressed.

Brief Description of the Drawings

Fig. 1 is a system diagram relating to this invention.

Fig. 2 is a flowchart showing the processing routine of an input circuit.

Fig. 3 is a flowchart showing the processing routine of a computation circuit.

Fig. 4 is a characteristic diagram showing a relation between a joystick voltage input value V_i , output operation value V_{oc} and a

displacement amount S of a hydraulic cylinder.

Fig. 5 is a characteristic diagram showing a relation between the joystick voltage input value V_i , output operation value V_{oc} and the displacement amount S of the hydraulic cylinder according to the prior art.

Fig. 6 is a characteristic diagram showing the relation of a time t after operating a joystick, and the displacement amount S of a hydraulic actuator.

Description of the Preferred Embodiments

This invention will now be described in further detail referring to the attached drawings.

Fig. 1 is a system diagram comprising a signal processor of a joystick input device. A hydraulic cylinder 22 is an actuator provided in a work machine such as a forklift. A proportional solenoid valve 20 changes over the flow of working oil supplied to or discharged from the oil hydraulic cylinder 22 via a pair of proportional solenoids 21, and thereby controls elongation and contraction of the hydraulic cylinder 22. The proportional solenoid valve 20 controls the rate at which the hydraulic cylinder 22 elongates and contracts by adjusting the flowrate of working oil according to an energizing current flowing through the proportional solenoids 21.

In Fig. 1, a symbol 10 is a joystick operated by an operator. A symbol 11 is a joystick input device outputting a joystick voltage input value V_i according to an operating amount of the joystick 10 which inclines from a neutral position. A symbol 12 is a controller controlling a current I which energizes the proportional solenoids 21 according to the joystick voltage input value V_i from the joystick input device 11.

A controller 12 comprises an input circuit (AD converter) 13 which changes the joystick voltage input value V_i from the joystick input device 11 into a digital signal, a computation circuit 14 which computes an output operation value V_{oc} set according to the joystick voltage input value V_i , an output circuit (DA converter) 15 which converts the computed output operation value V_{oc} into an analog signal V_o , and a drive circuit 16 which sends the output current I according to the output value V_o to the proportional solenoids 21.

The input circuit 13 reads the joystick voltage input value V_i at a predetermined sampling time (for example, 5 milliseconds), and converts the joystick voltage input value V_i into digital signal data.

However, if the computation circuit 14 computes the output computed value V_{oc} according to the joystick voltage input value V_i by using this data as it is, when the joystick input device 11 is operated rapidly, the working oil flow rate controlled by the proportional solenoid valve 20 changes suddenly, and a shock occurs in the motion of the work machine.

As the input means of this invention, the input circuit 13 reads the joystick voltage input value V_i at each predetermined sampling time, the average value of the data read for example over the past 15 occasions and on the present occasion is computed, and the computation result is output to the computation circuit 14 as a joystick voltage computation value V_{ic} . Hence, as the change in the output operation value V_{oc} is delayed relative to the change of the joystick voltage input value V_i , the operation of the proportional solenoid valve 20 is delayed.

A construction may also be used wherein the joystick voltage output value V_{ic} is computed in the computation circuit 14 as the input means of this invention.

The flowchart of Fig. 2 shows the processing routine of the input circuit 13, which is performed at a predetermined sampling time.

In a step S1, the joystick voltage input value V_i is read. In a step S2, the average value obtained by dividing the sum of the data read on the past 15 occasions times and the data read on the present occasion by 16, is computed as the joystick voltage computation value V_{ic} . In a step S3, interruption of the input circuit 13 is permitted.

For example, when the joystick input device 11 is operated rapidly and the joystick voltage input value V_i changes from 0 to X , the joystick voltage operation value V_{ic} is $X/16$ on the first sampling, the joystick voltage operation value V_{ic} is $2X/16$ on the second sampling, and the joystick voltage operation value V_{ic} is $16X/16 (=X)$ on the 16th sampling. If the sampling time is 5 milliseconds, the time taken to perform 16 samplings is $5 \times 16 = 80$ milliseconds, and the joystick voltage computation value V_{ic} converges after 80 has elapsed. For this reason, the proportional solenoid valve 20 operates over 80 milliseconds, and the working oil flow rate is adjusted by the proportional solenoid valve 20.

Thus, as the change of the output operation value V_{oc} computed by the computation circuit 14 is delayed relative to the change of the joystick voltage input value V_i from the joystick input device 11, the working oil flow rate controlled by the proportional solenoid valve 20 does not change suddenly due to sudden operation of a joystick 10, and a shock does not arise in the motion of the work machine.

The operational response of the proportional solenoid valve 20 can easily be changed by changing the number of data for computing the average value in the input circuit 13. That is, the response of the proportional solenoid valve 20 is increased by decreasing the number of data to compute the average value, and the response of the

proportional solenoid valve 20 is lowered by increasing the number of data to compute the average value.

The input circuit 13 computes the average value of data read over a predetermined number of past occasions and the data read on the present occasion at each sampling time, and outputs this computation result at any time to the computation circuit 14.

The computation circuit 14 computes the output computation value V_{oc} according to the joystick voltage operation value V_{ic} sent from the input circuit 13.

When operation starts wherein the joystick 10 inclines from the neutral position, and the joystick voltage operation value V_{ic} shifts from the neutral range to outside the neutral range, the joystick voltage input value V_i from the joystick input device 11 rises in a stepwise manner, as shown in Fig.5. However, the rise of the output current I which flows in the proportional solenoids 21 due to the inductance produced in the coils of the proportional solenoid 21 is delayed. Further, as there is an overlap part in which the flow of working oil through the proportional solenoid valve 20 does not change even if the valve body is moved slightly, the change-over response of the proportional solenoid valve 20 is not fully obtained at the start of operation when the joystick 10 is pushed over from the neutral position, and the start of operation of the hydraulic cylinder 22 is delayed.

To deal with this, an operation start detection means is provided which detects the start of operation when the joystick 10 is pushed over from the neutral position. Thus, the computation circuit 14 increases the output computation value V_{oc} to an effective value at the start of operation, momentarily causes the maximum rated current to flow in the proportional solenoids 21, and thereby increases the control

response.

Also the operation start detection means of the joystick 10 has provided a detection resistance 17 connected with the proportional solenoids 21 in series, an amplifier 18 which amplifies the voltage across the ends of the detection resistance 17, and a comparator 19 which compares the amplified voltage with a threshold voltage output from the output circuit 15. From the amplifier 18, a voltage corresponding to the output current I is output to the comparator 19, and when the joystick 10 is operated outside the neutral range, the threshold voltage from the output circuit 15 is output to the comparator 19. The comparator 19 determines whether or not the voltage from the amplifier 18 has risen above the threshold voltage, and this determination result is fed back to the computation circuit 14 as a digital signal.

As the computation means of this invention, at the start of operation when the joystick 10 is outside the neutral range and until the current I corresponding to the threshold value flows through the proportional solenoids 21, based on a signal from the comparator 19, the computation circuit 14 makes the output computation value V_{oc} an effective approximate maximum at which the maximum rated current flows in the proportional solenoids 21. When the current I corresponding to the threshold value flows in the proportional solenoids 21, the computation circuit 14 returns the output computation value V_{oc} to the set value according to the joystick voltage input value V_i .

The output computation value V_{oc} at the start of operation may be set arbitrarily according to the joystick voltage input value V_i , depending on the change-over response of the proportional solenoid valve 20 required, even if it is not increased to the effective maximum.

The flowchart of Fig. 3 shows the processing routine of the computation circuit 14, and is performed at a fixed interval.

In a step S11, the joystick voltage operation value V_{ic} sent from the input circuit 13 is read. In a step S12, the output computation value V_{oc} according to the joystick voltage operation value V_{ic} is calculated.

In a step S13, the feedback signal from the comparator 19 is read. In a step S14, it is determined whether or not the current I corresponding to the threshold value has flowed through the proportional solenoids 21.

Before the joystick voltage computation value V_{ic} rises and the current I corresponding to the threshold value flows through the proportional solenoids 21, the routine proceeds to a step S15, and the output computation value V_{oc} is set to the effective maximum.

When the joystick voltage computation value V_{ic} rises and the current I corresponding to the threshold value flows through the proportional solenoids 21, the routine proceeds to a step S16 and the output computation value V_{oc} is set to a value according to the joystick voltage computation value V_{ic} .

As shown in Fig. 4, when the joystick voltage input value V_i from the joystick input device 11 rises at the time of start of operation of the joystick 10, the output computation value V_{oc} momentarily increases to the effective maximum, and the maximum rated current I momentarily flows in the proportional solenoids 21. The effect of the inductance produced in the coils of the solenoids 21 is thereby decreased, and the current I which flows in the proportional solenoid valve 20 promptly increases.

The proportional solenoid valve 20 has an overlap part in which the flow of working oil does not change over even if the valve body

slides slightly between each position. As the current I flowing in the proportional solenoid valve 20 increases rapidly at the time of start of operation of the joystick 10, the valve body moves promptly to the overlap part, the change-over response of the position is improved, and the start of operation of the hydraulic cylinder 22 is advanced. Consequently, the time required for the hydraulic cylinder 22 to start moving is short, as the solid line in Fig.6 shows. On the other hand, after the valve body has moved through the overlap part, a sudden change of the current I flowing in the proportional solenoid valve 20 when there is a sudden operation of the joystick 10 is suppressed, and over-sensitivity in the motion of the hydraulic cylinder 22 is suppressed. As a result, the response with which the work device starts operation when the joystick 10 is operated, is improved, and the motion after operation starts is smooth.

Industrial Field of the Invention

As mentioned above, the signal processor of the joystick input device according to this invention is useful as a control device for work machines such as forklifts and power shovels, and suitable for use in a controller which controls the operation of a hydraulic actuator, especially through a proportional solenoid valve.

What is claimed

1. A signal processor for a joystick comprising; a joystick input device (11) which varies joystick voltage input value V_i according to an operating amount of a joystick (10) from a neutral position, an input means (13) which outputs the average value of the joystick voltage input value V_i read at every sampling time over a predetermined number of past occasions as a joystick voltage computation value V_{ic} , and computation means (14) which computes an output computation value V_{oc} set according to the joystick voltage computation value V_{ic} .
2. A signal processor for a joystick comprising; a joystick input device (11) which varies joystick voltage input value V_i according to an operating amount of a joystick (10) from a neutral position (11), an input means (13) which outputs the average value of the joystick voltage input value V_i read at every sampling time over a predetermined number of past occasions as a joystick voltage computation value V_{ic} , computation means (14) which computes an output computation value V_{oc} set according to the joystick voltage computation value V_{ic} , and operation start detecting means which detects an operation start when the joystick (10) is pushed over from the neutral position, wherein the computation means (14) increases the output computation value V_{oc} to a predetermined value according to the joystick voltage computation value V_{ic} when operation starts.
3. A signal processor for a joystick comprising; a joystick input device (11) which varies joystick voltage input value V_i according to an operating amount of a joystick (10) from a neutral position, an input

means (13) which outputs the average value of the joystick voltage input value V_i read at every sampling time over a predetermined number of past occasions as a joystick voltage computation value V_{ic} , computation means (14) which computes an output computation value V_{oc} set according to the joystick voltage computation value V_{ic} , and operation start detecting means which detects an operation start when the joystick (10) is pushed over from the neutral position, wherein the computation means (14) increases the output computation value V_{oc} to an effective maximum value when operation starts.

09/890543

Abstract

A signal processor for a joystick which comprises a joystick input device (11) which varies joystick voltage input value V_i according to an operating amount of a joystick (10) from a neutral position (11), an input means (13) which outputs the average value of the joystick voltage input value V_i read at every sampling time over a predetermined number of past occasions as a joystick voltage computation value V_{ic} , computation means (14) which computes an output computation value V_{oc} set according to the joystick voltage computation value V_{ic} , and operation start detecting means which detects an operation start when the joystick (10) is pushed over from the neutral position, are provided. The computation means (14) increases the output computation value V_{oc} to an effective maximum value when operation starts. In this way, over-sensitivity of control response when there is a sudden operation of the joystick 10 is suppressed.

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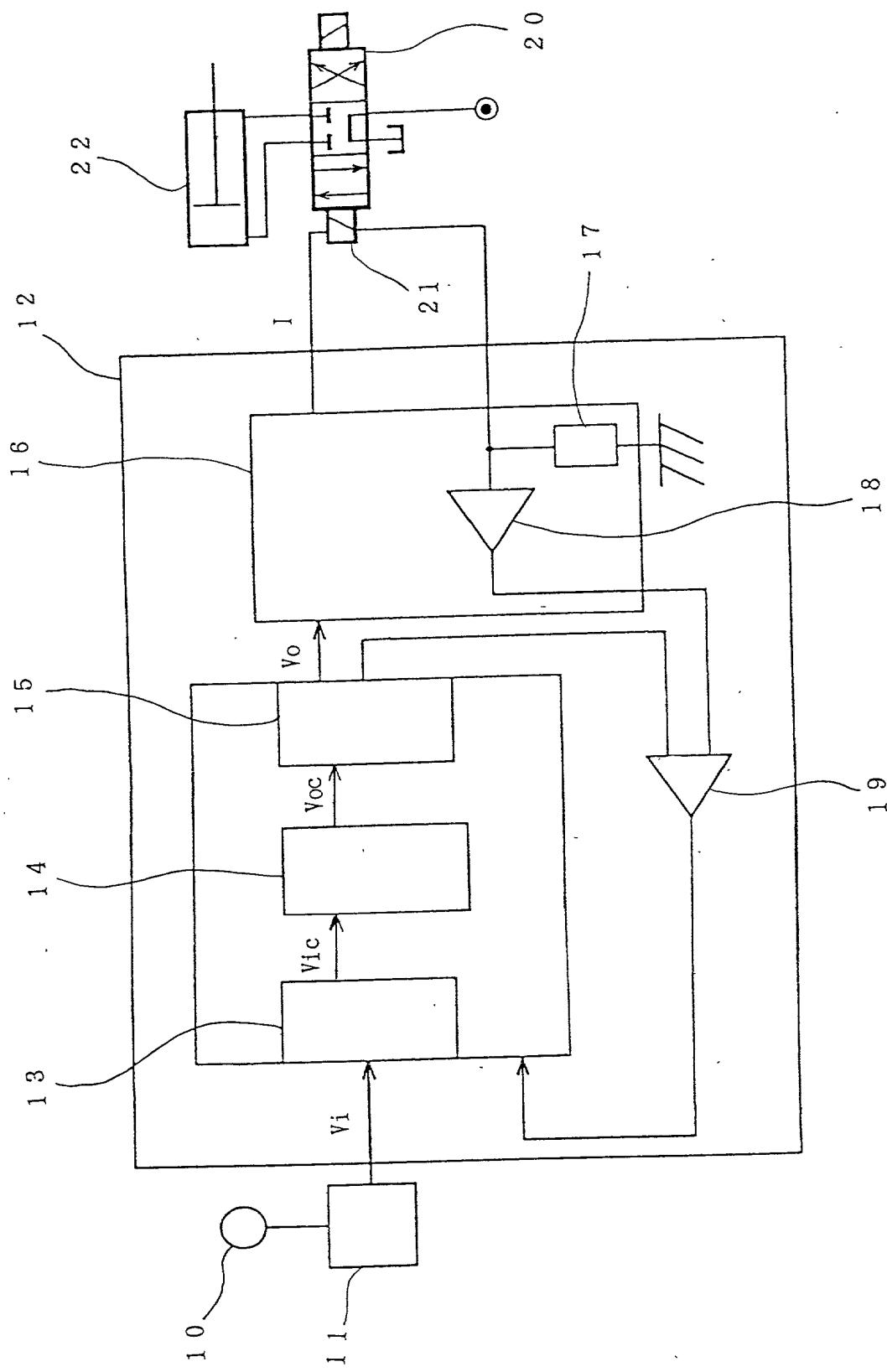


FIG. 1

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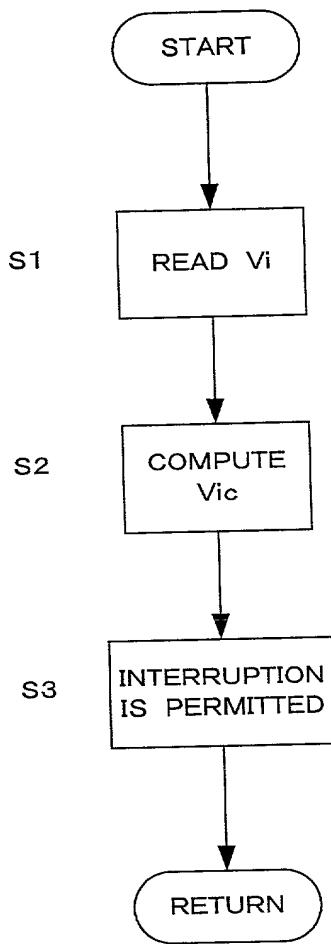


FIG. 2

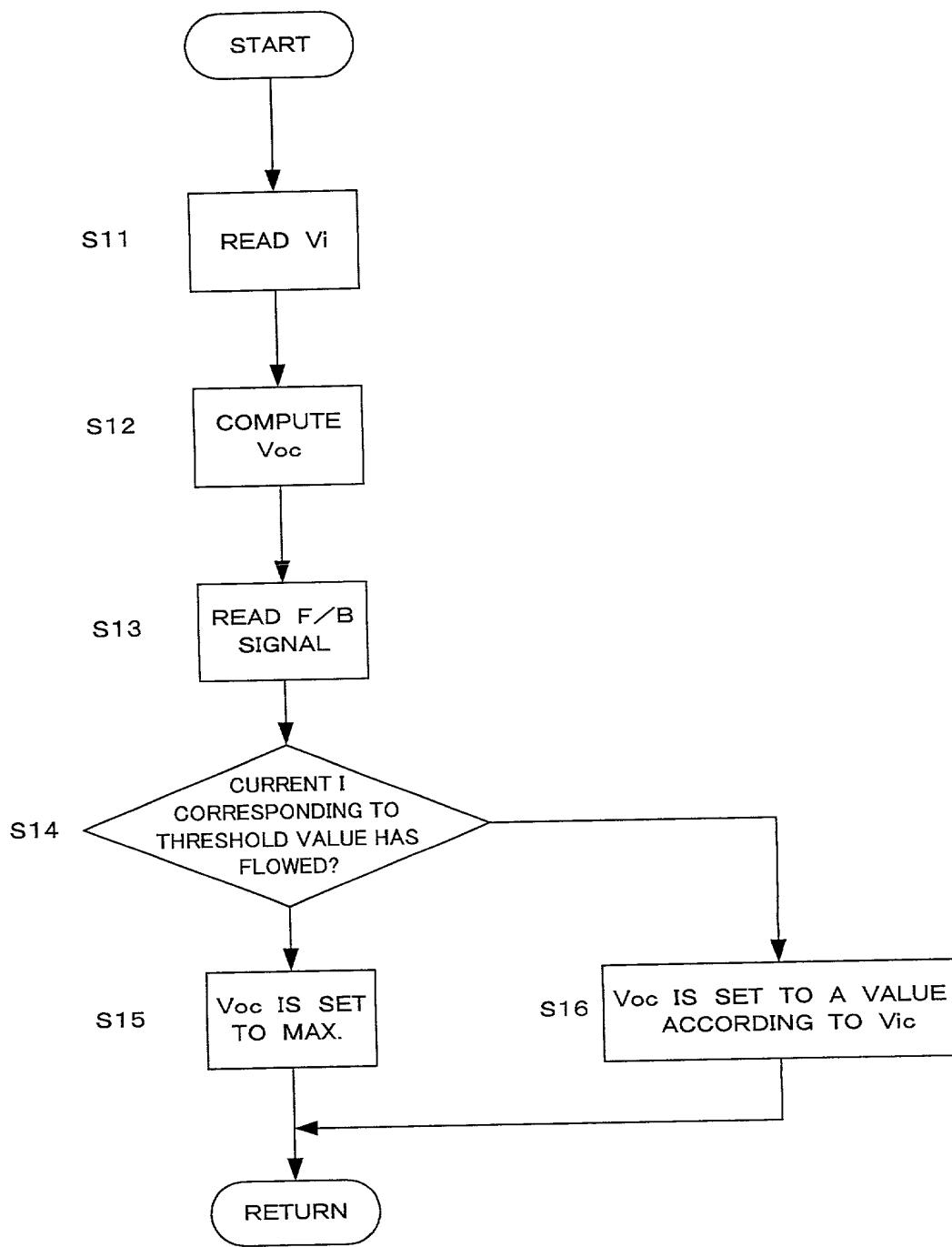


FIG. 3

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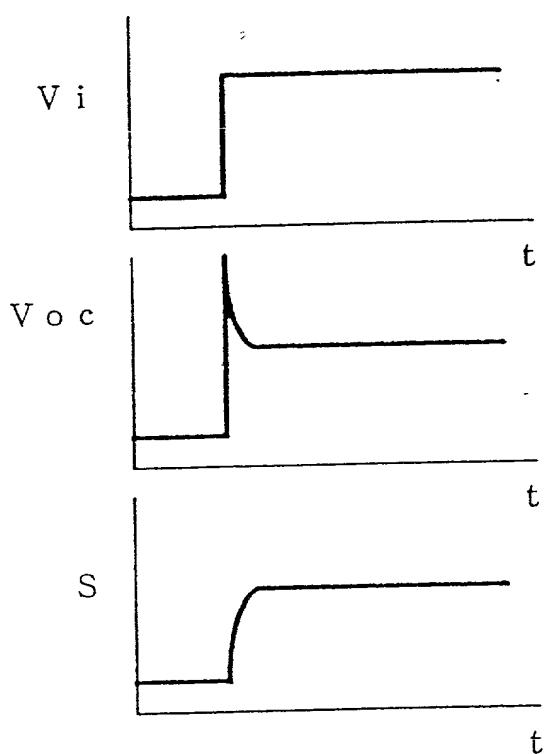


FIG. 4

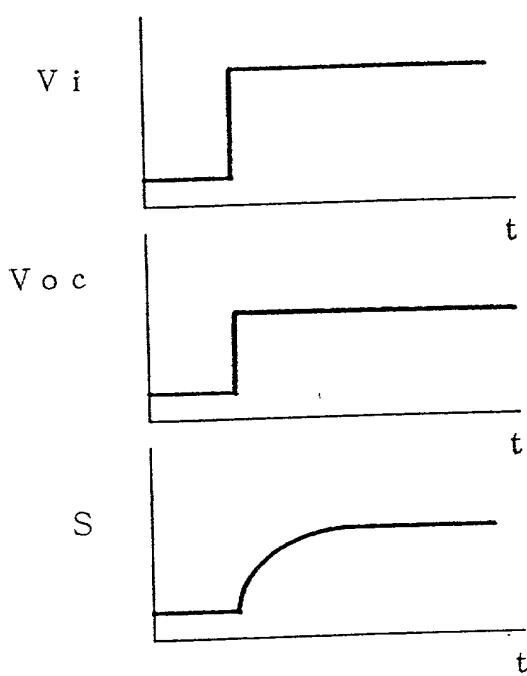


FIG. 5

09/29/05

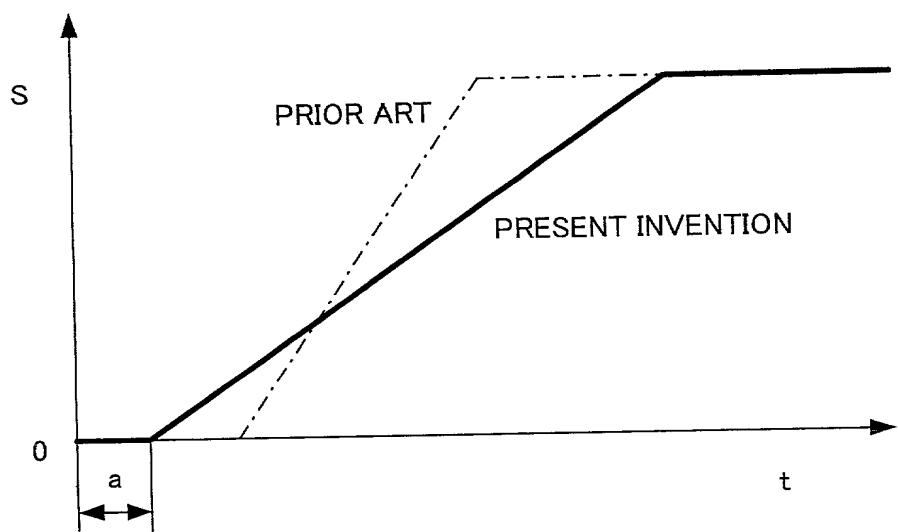


FIG. 6

00-1

Attorney Reference _____

**DECLARATION FOR UNITED STATES PATENT APPLICATION,
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SIGNAL PROCESSOR FOR A JOYSTICK INPUT DEVICE

the specification of which

is attached hereto.

[] was filed on _____, as Application Serial No. _____,
and was amended on _____ [if applicable].

was filed under the Patent Cooperation Treaty on December 28, 1999
Serial No JP 99/07389, the United States of America being designated.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose to the Patent and Trademark Office information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s) Number	Country	Date Filed	Priority Claimed Yes	Priority Claimed No

(4) I hereby appoint the following attorneys to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith: Steven M. Rabin (Reg. No. 29,102), Thomas M. Champagne (Reg. No. 36,478), Robert H. Berdo, Jr. (Reg. No. 38,075), and David S. Lee (Reg. No. 38,222), 1101 14th Street, N.W., Washington, D.C. 20005, Telephone: (202) 659-1915; Fax: (202) 659-1898. Address all correspondence to RABIN & CHAMPAGNE, P.C., 1101 14th Street, N.W., Suite 500, Washington, D.C. 20005.

The undersigned hereby authorizes the U.S. attorneys named herein to accept and follow instructions from the undersigned's assignee, if any, and/or, if the undersigned is not a resident of the United States, the undersigned's domestic attorney, patent attorney, patent agent, or patent representative as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00

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Citizenship: _____

Residence and Post Office Address: _____

Signature: _____ Date: _____ 20

Third Joint Inventor: _____

Citizenship: _____

Residence and Post Office Address: _____

Signature: _____ Date: _____ 20

Fourth Joint Inventor: _____

Citizenship: _____

Residence and Post Office Address: _____